The following is a list of the discussions that have been held:

NOVEMBER 13, 1923.

C. L. Mitchell: Aerological aids in forecasting the unusual movement of the Atlantic coast storm of October 23, 1923.
A. J. Henry: Variations in the levels of the central African lakes Victoria and Albert.[1] (Based on *Geophysical Memoirs, No. 20*, by C. E. P. Brooks.)
H. H. Kimball: On the variations of the sun's visible features associated with variations of solar radiation. (Based on paper of same title in *Proceedings of the National Academy of Sciences*, October, 1923, by C. G. Abbot.)

NOVEMBER 21, 1923.

W. J. Humphreys: Recent studies of the composition of the upper air.
C. LeRoy Meisinger: The mechanism of cyclones and anticyclones.[2] (Based on paper of same title in *Quarterly Journal of the Royal Meteorological Society*, July, 1923, by T. Kobayasi.)
F. G. Tingley: Further discussion of a proposed method of extrapolation of weather data, with a possible application to long-range forecasting.

DECEMBER 5, 1923.

A. J. Henry: Pacific LOWS and weather forecasting on the Pacific coast.

DECEMBER 19, 1923.

I. F. Hand: Investigation of the dust content of the atmosphere.[3]
S. P. Fergusson: Cloud systems. (Based on a memoir by Ph. Schreschewsky and Ph. Wehrlé of the Office National Météorologique de France.)

JANUARY 9, 1924.

O. L. Fassig (visiting official from San Juan, P. R.): Pilot-balloon work in Porto Rico.[4]

JANUARY 23, 1924.

C. F. Talman: An inspection of the Weather Bureau Library.

FEBRUARY 13, 1924.

E. W. Woolard: On the kinematics of an ideal cyclone.[5] (Based on a report of V. H. Ryd entitled "Travelling Cyclones." *Publikationer fra det Danske Meterologiske Institut*, Meddeleser Nr. 5, Copenhagen, 1923.)

FEBRUARY 20, 1924.

C. LeRoy Meisinger: The balloon project and what we hope to accomplish.[6]
H. W. Clough: A short cycle in terrestrial weather and its relation to solar data.[7]

A later issue of the REVIEW will contain programs for the remainder of the season.—*C. L. M.*

551.515

V. H. RYD ON TRAVELLING CYCLONES.[8]

By EDGAR W. WOOLARD.

[Weather Bureau, Washington, D. C., Feb. 13, 1924.]

In our efforts to explain natural phenomena and to construct comprehensive quantitative theories whereby what we have observed in the past is accurately described and what we shall observe in the future may be satisfactorily predicted, we are much handicapped by the extreme complexity of the actual conditions as found in Nature. In order that a problem may be handled at all by methods now available, it is almost always necessary to make "simplifying assumptions," i. e., to replace the intractable natural reality by a conceptual ideal; and it is to the latter that our subsequent discussion always applies. These assumptions are of such a character that the conditions subjected to theoretical investigation, while different from what we must assume to actually exist in Nature, are in general not so different that the results have no value as an indication of what may be conceived to happen in the natural reality.

It is sometimes necessary, however, to proceed by successive approximation, particularly at the start of an attack upon an especially complex problem. If an attempt be made to deal with *all* the complications of the natural reality, simultaneously and at the very beginning, no progress whatever may be possible; but by constructing successive workable ideals, each departing less and less from the natural reality, and noting carefully to what extent each suffices as a representation of what is observed actually to occur, a complete and satisfactory theory may eventually be worked out.

In Dynamical Meteorology not only are the problems involved extraordinarily complex, but we are at present handicapped by a lack of adequate observational data upon which to base the initial conceptual ideal, and whereby to check our resulting theories. However, the major features of actual phenomena are coming to be more and more satisfactorily represented in the theories of successive investigators. V. H. Ryd, of the Danish Meteorological Institute, to whom we owe a recent noteworthy attack on the problem of the circulation of the air in a cyclone, the source of the energy necessary for its maintenance, and the disposal of the rising air, states that "No theory of atmospheric mechanism can be proved directly, but the proof can be established gradually in an indirect manner. As a rule, the abundant explanations of meteorological phenomena from earlier days are based upon qualitative considerations only, but it might be difficult to set forth a theory so absurd that it could not be 'proved' in this manner. What can be done, and what ought to be done, is the making of *numerical computations by which it can be seen if the theory set forth is a probable one.* But, beyond this, the proof must rest with comparison with what is found in nature."

"If all the cases agree to a satisfactory degree, where such comparisons can be made, the theory must be taken as a true one for the present, and then without any hesitation we shall use conclusions drawn also where no comparison with facts can take place. On the contrary, when the theory disagrees with nature, it will depend on the special circumstances what is to be done. If the disagreement concerns the *foundation* itself, the theory must be considered as *a false one*, and it will be necessary to *abandon* it. On the other hand, if the disagreement concerns certain conclusions drawn from the theory, a new investigation can be made, and perhaps the result will be satisfactory when, for example, new circumstances are taken into consideration." Ryd deduces a theory of the pressure distributions and wind velocities at different levels in the cyclone, of the vertical circulation of the air at these levels, etc., and combines them into a description of the circulation of the air and the general mechanism of a travelling cyclone, illustrating and supporting his theory by a complete, worked out numerical example.[2]

[1] Discussion to appear in later REVIEW.
[2] This REVIEW, p. 37-38.
[3] To be discussed in a later REVIEW.
[4] This REVIEW, p. 22-26.
[5] This REVIEW, p. 36-37.
[6] This REVIEW, p. 27-29.
[7] This REVIEW, p. 38-39.
[8] Presented before the Weather Bureau Staff at its meeting of Feb. 13, 1924.

[2] Ryd, V. H.: Travelling Cyclones. *Publikationer fra det Danske Meteorologiske Institut, Meddelelser Nr. 5. Copenhagen, 1923.*

The cyclone considered is an ideal one, with circular isobars so spaced that the pressure distribution is amenable to mathematical expression and yet similar to what is often observed in real cyclones, superposed upon, and moving with uniform speed in a straight line through, a region of straight, parallel, equidistant isobars resulting from a distribution of temperature decreasing uniformly upward and northward in accordance again, roughly, with what is often observed. The latter pressure system, called the "stationary system," results in a geostrophic wind increasing upward, from zero at the surface, to great velocities at the cirrus level.

The fundamental differential equations of motion, which include the effects of turbulence and ground resistance, to which this scheme leads, can not be integrated; and the author develops a graphical method of solution, by which synchronous representations of air trajectories relative to the ground, trajectories relative to the moving center of the cyclone, and wind velocities relative to the ground, may be constructed for any level. From these, the regions of rising and falling air may be found also. The supply of energy necessary for the maintenance of a travelling wind system is assumed to come from the kinetic energy of the upper layers of the current produced by the stationary pressure system.

The cyclone, on this theory, may be divided into four principal or representative strata:

(1) The Ground Stratum, in which there is little or no wind arising from the stationary system; in this stratum, the actual wind velocities as depicted on a synoptic chart give the impression that the air is streaming from every side toward the center, but in reality the air streams into the cyclone only at the front; most of it leaves at the rear, but a minor part is drawn toward the center and must there ascend. Over most of the interior of the cyclone, air is rising; and in the outer parts and outside the cyclone proper, air is falling.

(2) The Lower Stratum of the free atmosphere, comprising that region in which the velocity of the wind due to the stationary system is *less* than the speed of the cyclone; in this stratum, a considerable part of the air spirals very slowly toward the center.

(3) The Central Part of the cyclone, in which the wind due to the stationary system has the *same* velocity as the speed of travel of the cyclone. Relative to the moving center, the air moves round and round this center in concentric circles. No addition to ascending or descending air is contributed by this stratum.

(4) The Higher Stratum of the free atmosphere, in which the wind due to the stationary system *exceeds* in velocity the speed of the cyclone; the air which is thrust up in the lower levels of the cyclone can not escape until it reaches this highest stratum, where it is carried forward out of the system. The descending air is similarly sucked from the highest stratum to the ground. The author considers that in most cases the decay of an Atlantic storm is due to the dying out or disturbance of the stationary pressure field.

An inversion of temperature will occur in the free air only where air is warmed up when contracted during descent, and, since this air is coming from the upper layers, it will be dry. However, a discontinuity of temperature, or "cold front" will be formed in the lowest level, at the place where observation shows the squall-line to exist; but the surfaces of discontinuity will vanish in the free air: The polar front is thus a consequence of the manner in which the air motions take place, and is not, as in Bjerknes' theories, the cause of the cyclone.

The theory is claimed to provide a foundation for an adequate explanation of extratropical cyclones; and the author is satisfied that it is in reasonable accord with observed facts. A number of facts which are explained by the theory are pointed out; and a critical examination of the foundations and postulates of the theory leaves a favorable impression. Of course, a *complete* theory must take into account many factors necessarily neglected in this study.

The kinematical problem with which Ryd has concerned himself is quite similar to the one recently investigated by Kobayasi, and the conclusions of the two are substantially in agreement.[3]

ON THE MECHANISM OF CYCLONES AND ANTICYCLONES.

551.515(048)

By T. KOBAYASI.

[Abstracted from *the Quarterly Journal of the Royal Meteorological Society*, July, 1923, pp. 177–189.]

Contrary to the Bjerknes conception of the function of the polar front as a causative factor in the formation of cyclones and anticyclones, the author begins by regarding the cyclone as a circular phenomenon. This suggestion arises from the widely observed fact that not all cyclones have a well-defined polar front, especially those that are slow moving.

Therefore, regarding the cyclone kinematically, the author deduces mathematically the equations of air trajectories over the earth's surface. To accomplish this, certain assumptions are necessary: (1) In the central region of a cyclone, called by the author the "principal part," there is not great variation of wind speed with increase of distance from the center; (2) outside the "principal part" the air is moving horizontally; (3) in the "principal part," at the surface, the wind is moving relative to the center approximately three times as fast as the center is advancing, and at an angle of 20° to the isobars. The resultant air trajectories thus theoreticalld obtained agree fairly well with those found by Shaw any Lempfert in their study of the "Life history of surface air currents." In the treatment of more complicated conditions the determination of theoretical air trajectories must be graphical but the results will not differ much from those found in this study, providing it is always assumed that within the storm the air is moving faster than the velocity of translation of the center and that at a distance from the center the air is moving slower than the velocity of translation.

The important feature thus revealed is that, along a line extending from the center of the cyclone toward the southwest there will occur a sharp discontinuity of temperature *if there is a steep horizontal gradient of temperature normal to the direction of translation of the cyclone.* If there is no such temperature gradient in the field of the storm's activity, this thermal discontinuity will not appear. This line corresponds to the well-known Bjerknes "cold front." The author maintains, it is seen, that the thermal discontinuity is a *result* and not a *cause* of the cyclone.

The angle between the actual wind and the gradient decreases with increase of altitude, and the ratio of wind velocity to velocity of translation of the pressure system also increases. At a certain height, assumed by the author to be 1,000 meters, the angle becomes 0° and this

[3] See this REVIEW, pp. 37–38.